

Noble gas composition in hot spring gas in Shikine Island, Izu–Bonin volcanic arc, Japan

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Shikine island is located on the rear-arc side of the northern part of the Izu–Bonin arc, and is a rhyolite-dominated volcano which erupted in ca. 8000 years ago. Recently, the CO₂-rich emission were found in coastal area of southern Shikine island (Agostini et al., 2015 RSMS). It is considered that its gas is volcanic gas.

Geochemical features of volcanic gas provide important information on both the current status of cooling magma batches intruding the upper crust and interaction processes taking place between rising fluids and hosting rocks. Especially, noble gases have great potential as tracers for mantle sources and fingerprinting of geothermal reservoirs (Pinti et al., 2013, JVGR), because the noble gases in the gas are derived from three potential sources: the crust, the mantle, and the atmosphere. We report noble gas composition of hot spring free gases collected from 2 sites (Mikawa-bay and Jinata-hot spring) in coastal area of southern Shikine island during 2016 to 2019.

The measured ³He/⁴He ratios were corrected for atmospheric contamination based on ⁴He/²⁰Ne ratios. The air-corrected ³He/⁴He ratios ranged from 7.8 to 8.0 Ra, where 1 Ra denotes atmospheric ³He/⁴He ratio of 1.4×10⁻⁶ (Ozima and Podosek, 2002, Noble Gas Geochemistry). This value is similar to that (8±1 Ra) of the upper mantle estimated from mid-ocean ridge basalts (MORB). The ²⁰Ne/²²Ne and ²¹Ne/²²Ne ratios of the samples ranged from 9.86 to 9.93 and from 0.0292 to 0.0294, respectively, which are totally similar to the atmospheric component (9.80 for ²⁰Ne/²²Ne and 0.0290 for ²¹Ne/²²Ne; Ozima and Podosek, 2002). The ³⁸Ar/³⁶Ar ratios or 0.187–0.189 were also atmospheric (0.188; Ozima and Podosek, 2002). In contrast, the ⁴⁰Ar/³⁶Ar ratios ranging from 297 to 300, were slightly higher than that of the atmosphere component (296.0; Nier, 1950, Physical Review), suggesting that they reflect the gas source. Noble gas relative abundances are given using the F-value notation (Ozima and Podosek, 2002) in which measured abundances are normalized to the air abundance with ³⁶Ar as the reference isotope, i.e., F(i)=(i/³⁶Ar)_{sample} / (i/³⁶Ar)_{atmosphere}. Some researchers suggested that the relative abundances in fumaroles and hot-spring gases in geothermal area reflect elemental fractionation during boiling and steam separation at hydrothermal temperatures (Pinti et al., 2013 JVGR). The condensation temperature in the present area is estimated as about 150°C adopting the model of batch fractionation using an initial air saturated seawater end-member at 25°C to the observed F(²⁰Ne) and F(¹³²Xe).

Keywords: Noble gas composition, Shikine Island, Hot spring gas